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(54) **SYSTEMS, METHODS, AND APPARATUSES FOR ROUTING API CALLS**

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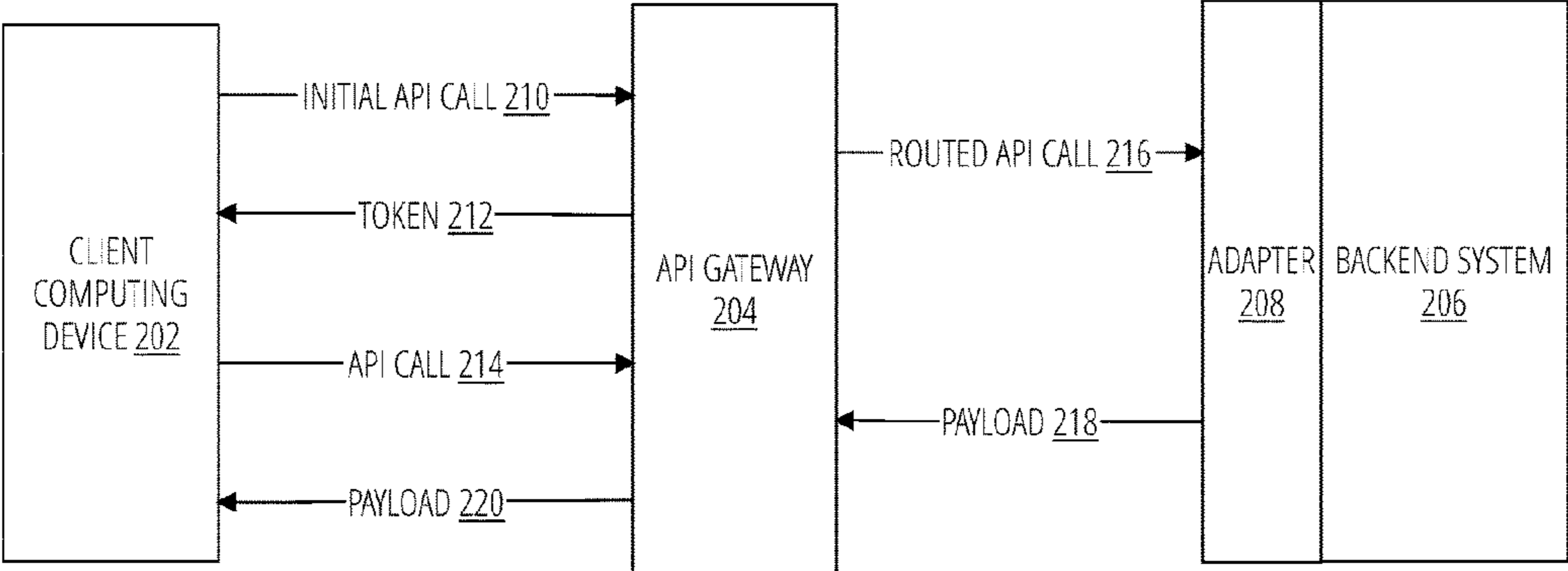
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(57) **ABSTRACT**

The present disclosure relates to methods, systems and apparatuses for routing API calls to multiple backend systems that share a common API. A system may receive an API call comprising a unique identifier from a client computing device. The system may identify the unique identifier in the API call, and determine a target backend system associated with the unique identifier from the plurality of backend systems. Further, the system may route the API call to the target backend system based on the unique identifier.

14 Claims, 5 Drawing Sheets

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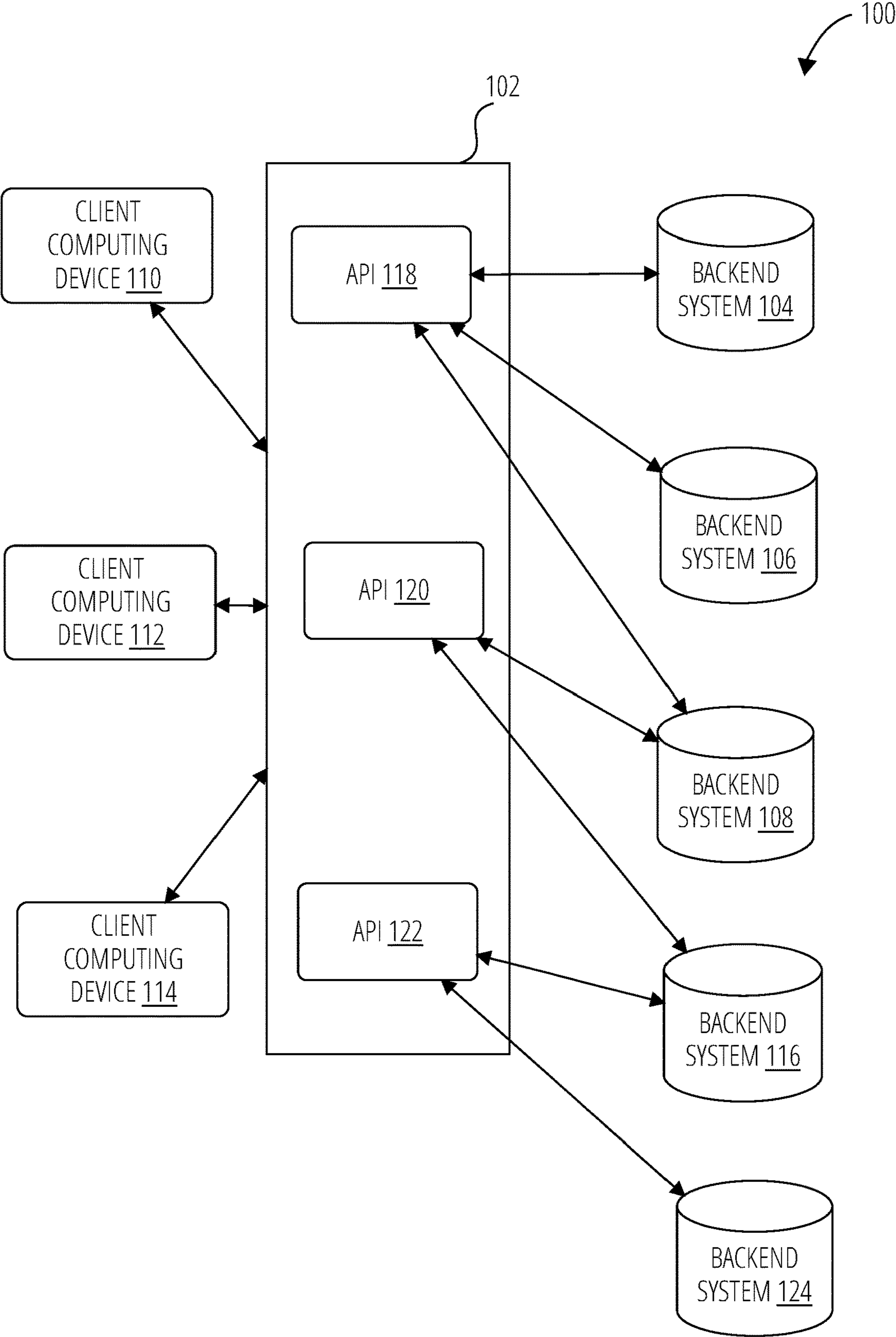


FIG. 1

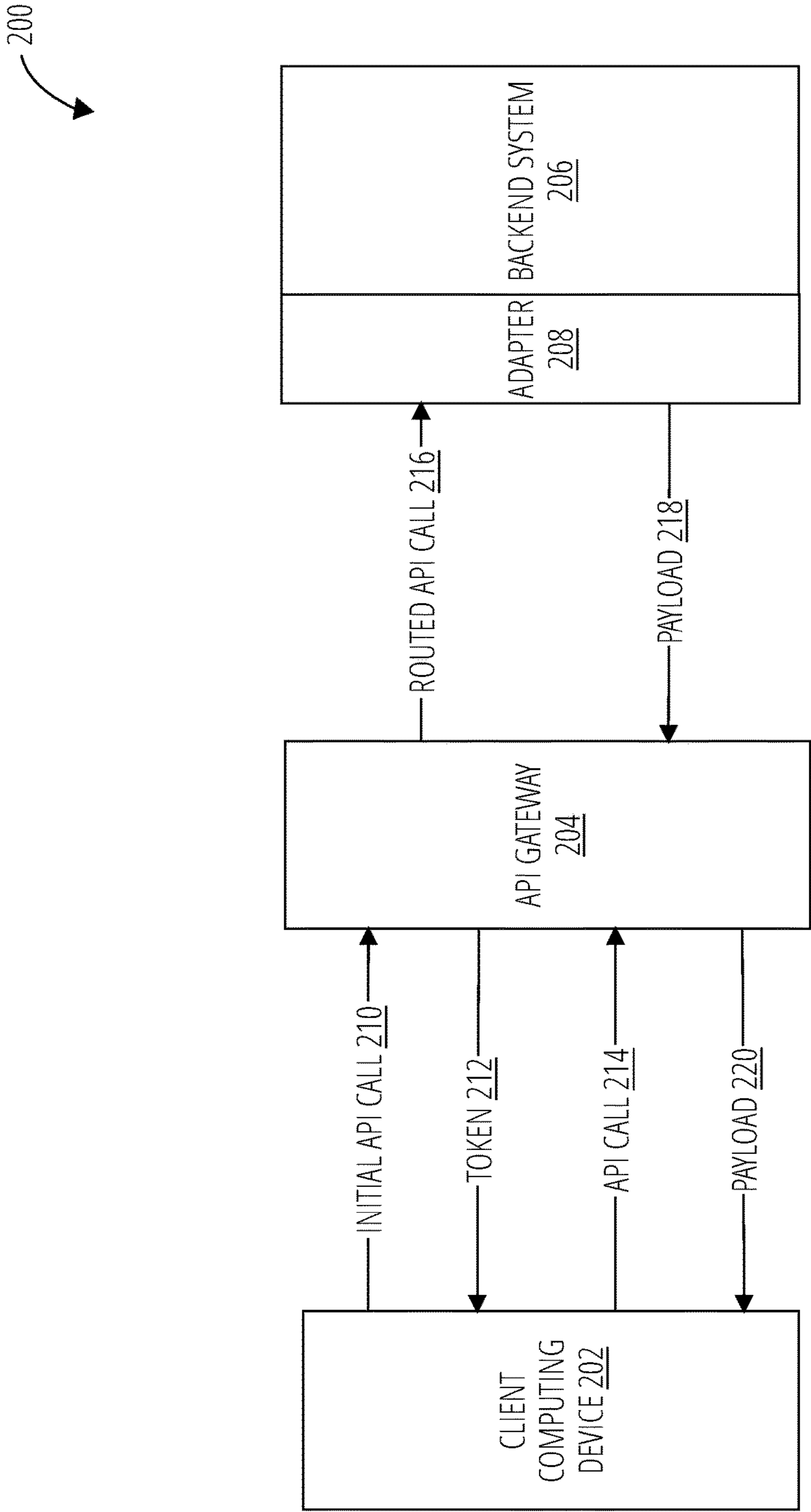


FIG. 2

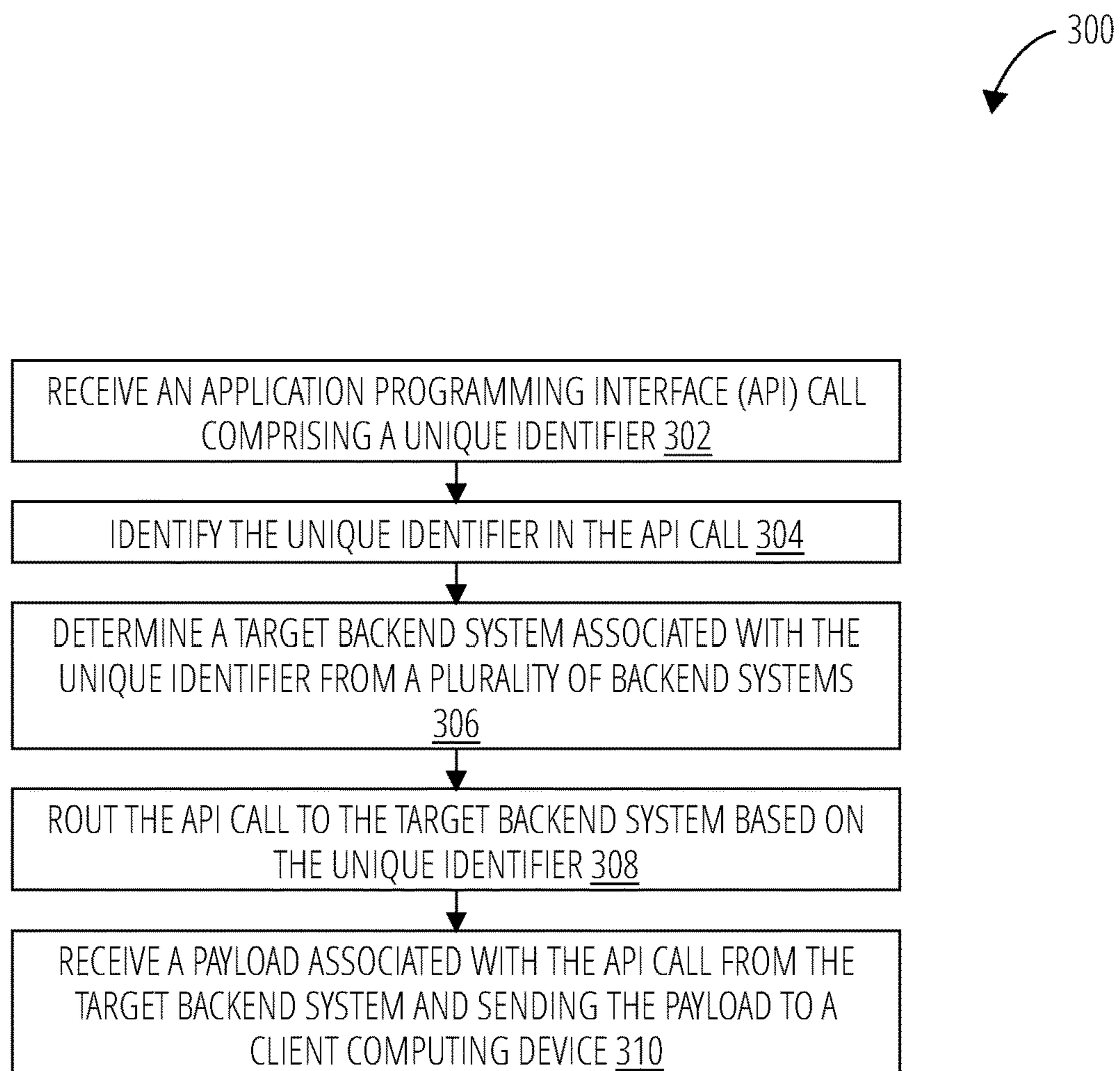


FIG. 3

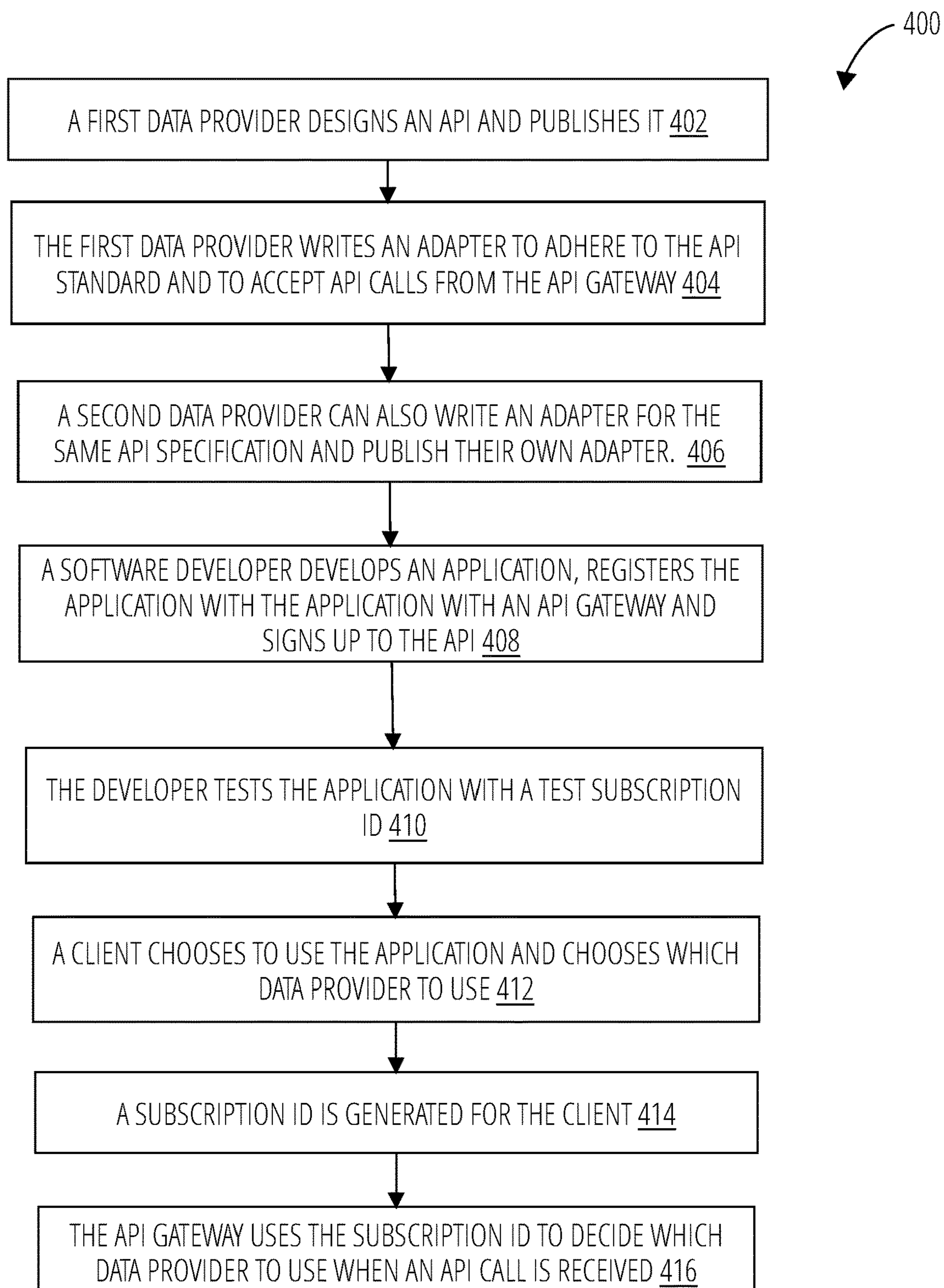


FIG. 4

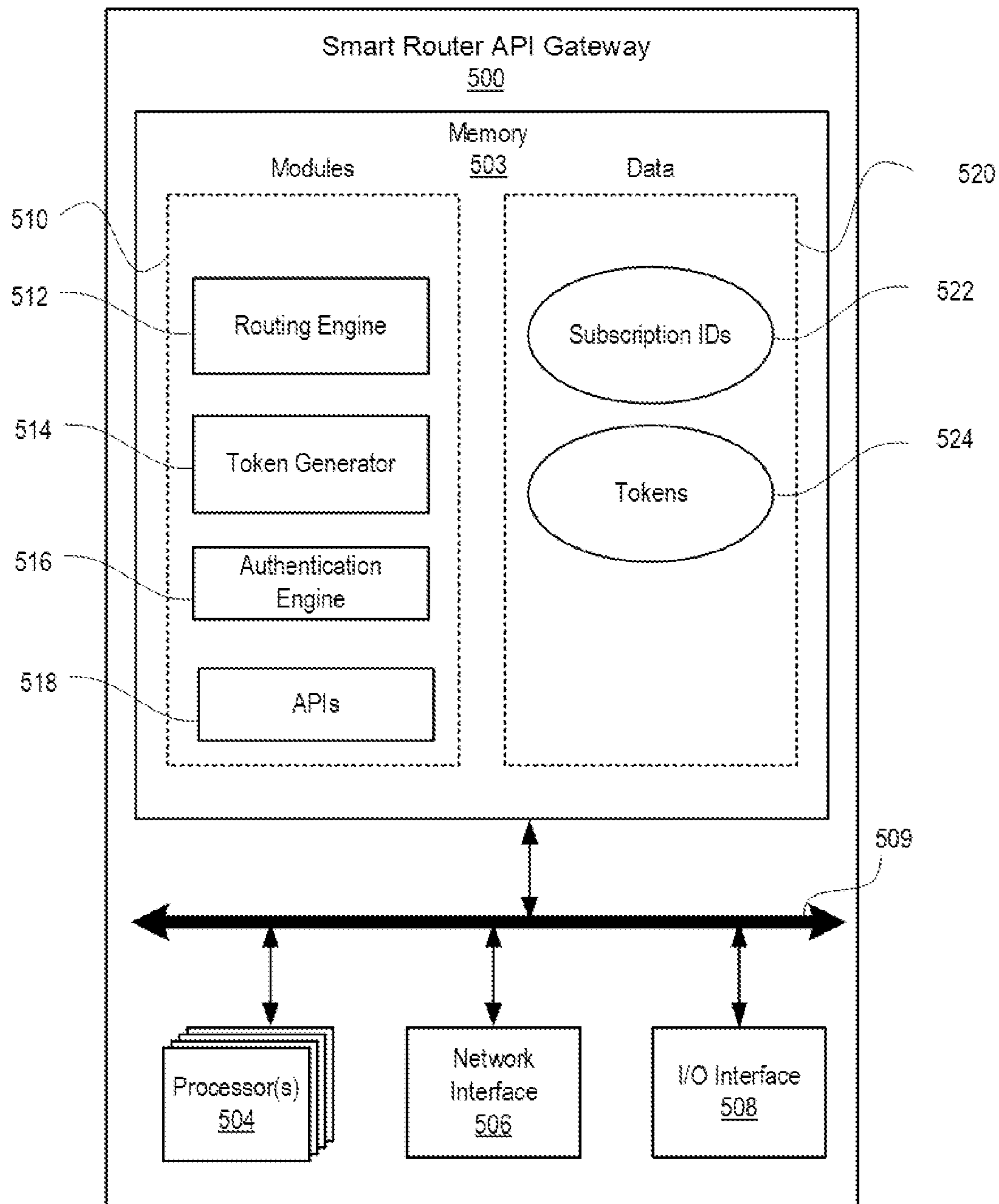


FIG. 5

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SYSTEMS, METHODS, AND APPARATUSES
FOR ROUTING API CALLS

TECHNICAL FIELD

The present disclosure relates generally to handling API calls. More specifically, the present disclosure relates to methods, systems and apparatuses for routing API calls to multiple backend systems that share a common API.

BRIEF DESCRIPTION OF THE SEVERAL
VIEWS OF THE DRAWINGS

To easily identify the discussion of any particular element or act, the most significant digit or digits in a reference number refer to the figure number in which that element is first introduced.

FIG. 1 illustrates a block diagram of an API call routing system **100** in accordance with one embodiment.

FIG. 2 illustrates a simplified signal flow diagram **200** for a smart routing API gateway **204** in accordance with one embodiment.

FIG. 3 illustrates a method **300** to route an API call in accordance with one embodiment.

FIG. 4 illustrates a method **400** to create and implement an API common to multiple backend systems in accordance with one embodiment.

FIG. 5 is a block diagram of a smart router API gateway smart router API gateway **500** according to one embodiment.

DETAILED DESCRIPTION

Described herein are embodiments of systems, apparatuses, and methods for routing Application Programming Interface (API) calls using a common API to multiple backend systems. An API gateway is a way to connect various developers or applications to a backend system. Traditional API gateways use an API to connect a client competing device to services of a single backend system. Unlike traditional API gateways, the embodiments herein include smart routing API gateways that can reuse a single API for to connect multiple different applications and clients to multiple different backend systems.

Using a common API to connect multiple applications to multiple backend systems can lead to greater computing efficiencies. For instance, the traditional API gateway can receive API calls from many client computing devices and routes them to a single backend system. However, this means that for each backend system, the developer would have to develop multiple integrations of an API if it was desired to use the API with multiple backend systems. In contrast, the smart routing API gateway is capable of connecting many client computing devices and applications to many backend systems. This allows a developer to develop a single API that can be used to access multiple backend systems. Thus, with a smart routing API gateway fewer application integrations would need to be developed.

In some embodiments herein, an API gateway may receive an API call comprising a unique identifier. The API gateway may identify the unique identifier in the API call and determine a target backend system associated with the unique identifier from a plurality of backend systems. The API gateway may then route the API call to the target backend system based on the unique identifier.

The phrases “coupled to,” “connected to,” and “in communication with” refer to any form of interaction between

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two or more components, including mechanical, electrical, magnetic, and electromagnetic interaction. Two components may be connected to each other, even though they are not in direct contact with each other, and even though there may be intermediary devices between the two components.

It will be readily understood that the components of the embodiments as generally described below and illustrated in the Figures herein could be arranged and designed in a wide variety of different configurations. For instance, the steps of a method do not necessarily need to be executed in any specific order, or even sequentially, nor do the steps need to be executed only once. Thus, the following more detailed description of various embodiments, as described below and represented in the Figures, is not intended to limit the scope of the disclosure but is merely representative of various embodiments. While the various aspects of the embodiments are presented in the drawings, the drawings are not necessarily drawn to scale unless specifically indicated.

Embodiments and implementations of systems and methods described herein may include various steps, which may be embodied in machine-executable instructions to be executed by a computer system. A computer system may include one or more general-purpose or special-purpose computers (or other electronic devices). The computer system may include hardware components that include specific logic for performing the steps or may include a combination of hardware, software, and/or firmware.

Embodiments may be provided as a computer program product including a computer-readable medium having stored thereon instructions that may be used to program a computer system or other electronic device to perform the processes described herein. The computer-readable medium may include, but is not limited to: hard drives, floppy diskettes, optical disks, CD-ROMs, DVD-ROMs, ROMs, RAMs, EPROMs, EEPROMs, magnetic or optical cards, solid-state memory devices, or other types of media/computer-readable media suitable for storing electronic instructions.

Computer systems and the computers in a computer system may be connected via a network. Suitable networks for configuration and/or use as described herein include one or more local area networks, wide area networks, metropolitan area networks, and/or Internet or IP networks, such as the World Wide Web, a private Internet, a secure Internet, a value-added network, a virtual private network, an extranet, an intranet, or even stand-alone machines which communicate with other machines by physical transport of media. In particular, a suitable network may be formed from parts or entireties of two or more other networks, including networks using disparate hardware and network communication technologies.

One suitable network includes a server and several clients; other suitable networks may contain other combinations of servers, clients, and/or peer-to-peer nodes, and a given computer system may function both as a client and as a server. Each network includes at least two computers or computer systems, such as the server and/or clients. A computer system may include a workstation, laptop computer, disconnectable mobile computer, server, mainframe, cluster, so-called “network computer” or “thin client,” tablet, smart phone, personal digital assistant or other hand-held computing device, “smart” consumer electronics device or appliance, medical device, or a combination thereof.

Suitable networks may include communications or networking software, such as the software available from Novell®, Microsoft®, and other vendors, and may operate using TCP/IP, SPX, IPX, and other protocols over twisted

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pair, coaxial, or optical fiber cables; telephone lines; radio waves; satellites; microwave relays; modulated AC power lines; physical media transfer; and/or other data transmission “wires” known to those of skill in the art. The network may encompass smaller networks and/or be connectable to other networks through a gateway or similar mechanism.

Each computer system includes one or more processors and/or memory; computer systems may also include various input devices and/or output devices. The processor may include a general-purpose device, such as an Intel®, AMD®, or other “off-the-shelf” microprocessor. The processor may include a special-purpose processing device, such as an ASIC, SoC, SiP, FPGA, PAL, PLA, FPLA, PLD, or other customized or programmable device. The memory may include static RAM, dynamic RAM, flash memory, one or more flip-flops, ROM, CD-ROM, disk, tape, magnetic, optical, or other computer storage medium. The input device(s) may include a keyboard, mouse, touch screen, light pen, tablet, microphone, sensor, or other hardware with accompanying firmware and/or software. The output device(s) may include a monitor or other display, printer, speech or text synthesizer, switch, signal line, or other hardware with accompanying firmware and/or software.

The computer systems may be capable of using a floppy drive, tape drive, optical drive, magneto-optical drive, or other means to read a storage medium. A suitable storage medium includes a magnetic, optical, or other computer-readable storage device having a specific physical configuration. Suitable storage devices include floppy disks, hard disks, tape, CD-ROMs, DVDs, PROMs, RAM, flash memory, and other computer system storage devices. The physical configuration represents data and instructions which cause the computer system to operate in a specific and predefined manner as described herein.

Suitable software to assist in implementing the invention is readily provided by those of skill in the pertinent art(s) using the teachings presented here and programming languages and tools, such as JavaScript, Modern Fortran, Java, Pascal, C++, C, PHP, .Net, database languages, APIs, SDKs, assembly, firmware, microcode, and/or other languages and tools. Suitable signal formats may be embodied in analog or digital form, with or without error detection and/or correction bits, packet headers, network addresses in a specific format, and/or other supporting data readily provided by those of skill in the pertinent art(s).

Aspects of certain embodiments may be implemented as software modules or components. As used herein, a software module or component may include any type of computer instruction or computer executable code located within or on a computer-readable storage medium. A software module may, for instance, comprise one or more physical or logical blocks of computer instructions, which may be organized as a routine, program, object, component, data structure, etc., that performs one or more tasks or implement particular abstract data types. A particular software module may comprise disparate instructions stored in different locations of a computer-readable storage medium, which together implement the described functionality of the module. Indeed, a module may comprise a single instruction or many instructions, and may be distributed over several different code segments, among different programs, and across several computer-readable storage media.

Some embodiments may be practiced in a distributed computing environment where tasks are performed by a remote processing device linked through a communications network. In a distributed computing environment, software modules may be located in local and/or remote computer-

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readable storage media. In addition, data being tied or rendered together in a database record may be resident in the same computer-readable storage medium, or across several computer-readable storage media, and may be linked together in fields of a record in a database across a network. According to one embodiment, a database management system (DBMS) allows users to interact with one or more databases and provides access to the data contained in the databases.

FIG. 1 illustrates a block diagram of an API call routing system **100** in accordance with one embodiment. As shown, the API call routing system **100** may include a plurality of client computing devices (e.g., first client computing device **110**, second client computing device **112**, and third client computing device **114**), an API gateway **102**, and a plurality of backend systems (e.g., first backend system **104**, second backend system **106**, third backend system **108** fourth backend system **116**, and fifth backend system **124**).

The client computing devices may be configured for a variety of clients. For example, the client computing devices may be used for a plurality of different car dealerships. Each client may use one or more applications for their business. Therefore, each client computing device may have one or more applications. The applications may include applications related to finances, inventory management, contact management, and scheduling management. The client computing devices may communicate with the API gateway **102**. For example, the client computing devices may make API calls to the API gateway **102** and receive payloads associated with the calls.

The API calls may be a request by an application on a client computing device for information from one of the backend systems. The backend systems may store information and provide one or more services. The backend systems may be separately maintained systems that do not communicate directly with one another. In some embodiments, the backend systems may be managed by different companies. The backend systems may be controlled by one or more data providers. For example, the backend systems may be car dealer management system, a statistic provider, an insurance company, etc.

As shown, the API gateway **102** may route API calls from the client computing devices to the appropriate backend system using one of the APIs (e.g., first API **118**, second API **120**, and third API **122**). As shown, some APIs may be capable of communicating with multiple databases. Thus, an API call from a client computing device may correspond to an API that is common to multiple backend systems.

Accordingly, when the API gateway **102** receives an API call, the associated API may determine the proper backend system to route the call too. In some embodiments, the API call routing system **100** may use unique identifiers in the API call to indicate which backend system to use. The unique identifiers may be subscription identifiers that are unique to an application, a client, or a combination of the application for a client. In some embodiments, the unique identifiers may be part of the API header. In some embodiments, the unique identifiers may be part of the API payload. In some embodiments, the unique identifiers may be a universally unique identifier (UUID) or a globally unique identifier (GUID). The unique identifiers may be 24 bytes or 36 bytes.

FIG. 2 illustrates a simplified signal flow diagram **200** for a smart routing API gateway **204** in accordance with one embodiment. As shown, the API gateway **204** may use token-based security to prevent unauthorized access to the

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multiple backend systems in communication with the API gateway **204**. For example, the API gateway **204** may use OAUTH security.

The client computing device **202** may send an initial API call **210** to the API gateway **204**. The initial API call **210** may be sent when a client is setting up an application. The initial API call **210** may initiate interaction between the client computing device **202** and the API gateway **204** and be used to receive a token **212**. The token may be used to provide authorization of future API calls. For example, the token may be issued to determine what application and client has authority to access a data source (e.g., backend system **206**).

The client computing device **202** may send an API call **214** to the API gateway **204**. The API call **214** may include a unique identifier such as a subscription identifier for the client and application. The client computing device **202** may also send the token with the API call **214**. The API gateway **204** may check that the token is still authorized for the application and client that sent the API call **214**. If the API call **214** is authorized to proceed, the API gateway **204** may determine the unique identifier in the API call **214** and determine which backend system to route the API call **214**.

In the illustrated embodiment, the API gateway **204** determines that the unique identifier is associated with the backend system **206**. Accordingly, the API gateway **204** sends a routed API call **216** to the backend system **206**. An adapter **208** formats the routed API call **216** for the backend system **206**. The backend system **206** responds to the routed API call **216** by sending a payload **218** to the API gateway **204**. The API gateway **204** may forward the payload **220** to the client computing device **202**.

FIG. **3** illustrates a method **300** to route an API call in accordance with one embodiment. A system implementing the method **300** may receive **302** an API call comprising a unique identifier. The system may identify **304** the unique identifier in the API call. The unique identifier may be a subscription identifier unique to an application and a client. In some embodiments, the unique identifier may be in the header of the API call. In some embodiments, the unique identifier may be in the payload of the API call.

The system may determine **306** a target backend system associated with the unique identifier from a plurality of backend systems. The API call may correspond to an API that is common to multiple backend systems communicatively coupled with the router. Accordingly, the system may determine how to route the API call based on the unique identifier.

The system may route **308** the API call to the target backend system based on the unique identifier. The target backend system may be one of a dealer management system, a statistic provider, or an insurance company. In some embodiments, the backend systems that are associated with the API may be from different data providers. The system may receive **310** a payload associated with the API call from the target backend system and send the payload to a client computing device. In some embodiments, the system may receive a token with the API call and check that the token is valid for the unique identifier of the API call.

FIG. **4** illustrates a method **400** to create and implement an API common to multiple backend systems in accordance with one embodiment. In the method **400**, a first data provider designs **402** an API and publishes it. The data provider may be an automobile dealer management system, statistic provider, or an insurance company.

This API may be used by other data providers for their backend systems. For example, a second data provider can

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also write **406** an adapter for the same API specification and publish their own adapter. Using a common API for multiple data providers or multiple backend systems allows for fewer APIs which may assist the data providers and software developers as there are fewer APIs needed to be developed and applications will not have to be written for multiple APIs. Additionally, this may provide a client with a choice of providers for the data.

In the method **400**, a software developer develops **408** an application, registers the application with the application with an API gateway, and signs up to the API. The software developer may test **410** the application with a test subscription ID. A client may choose **412** to use the application and choose which data provider to use **412**.

A subscription ID may be generated **414** for the client for the application. The API gateway may use **416** the subscription ID to decide which data provider to use when an API call is received. Thus, the API gateway serves as a smart router to route API calls to a correct backend system and data provider. This means that multiple data providers can be accessed by the application without the software developer writing another specific integration of the application.

FIG. **5** is a block diagram of a smart router API gateway smart router API gateway **500** according to one embodiment. The smart router API gateway **500** may perform the methods and use the techniques described with reference to the other figures in the specification. The smart router API gateway **500** can include a memory **503**, one or more processors **504**, a network interface **506**, an input/output interface **508**, and a system bus **509**.

The one or more processors **504** may include one or more general purpose devices, such as an Intel®, AMD®, or other standard microprocessor. The one or more processors **504** may include a special purpose processing device, such as ASIC, SoC, SiP, FPGA, PAL, PLA, FPLA, PLD, or other customized or programmable device. The one or more processors **504** can perform distributed (e.g., parallel) processing to execute or otherwise implement functionalities of the presently disclosed embodiments. The one or more processors **504** may run a standard operating system and perform standard operating system functions. It is recognized that any standard operating systems may be used, such as, for example, Microsoft® Windows®, Apple® MacOS®, Disk Operating System (DOS), UNIX, IRIX, Solaris, SunOS, FreeBSD, Linux®, fliM® OS/2® operating systems, and so forth.

The memory **503** may include static RAM, dynamic RAM, flash memory, one or more flip-flops, ROM, CD-ROM, DVD, disk, tape, or magnetic, optical, or other computer storage medium. The memory **503** may include a plurality of program modules **510** and program data **520**. The memory **503** may be local to the smart router API gateway **500**, as shown, or may be distributed and/or remote relative to the smart router API gateway **500**.

Data generated or used by the smart router API gateway **500**, such as by the program modules **510** or other modules, may be stored on the memory **503**, for example, as stored program data **520**. The data **520** may be organized as one or more databases.

The data **520** may include subscription IDs **522** and tokens **524**. The subscription IDs **522** may be unique identifiers for an application, a client, or a combination of the application and client. The subscription ID may be assigned per application and client during a setup process of the application. The smart router API gateway **500** may associate the subscription ID with a backend system that the client indicated. The smart router API gateway **500** may

route API calls to the indicated backend system. The tokens **524** may be used to authorize access to backend systems for applications and clients.

The program modules **510** may run multiple operations concurrently or in parallel by or on the one or more processors **504**. In some embodiments, portions of the disclosed modules, components, and/or facilities are embodied as executable instructions embodied in hardware or firmware, or stored on a non-transitory, machine-readable storage medium. The executable instructions may comprise computer program code that, when executed by a processor and/or computing device, cause a computing system to implement certain processing steps, procedures, and/or operations, as disclosed herein. The modules, components, and/or facilities disclosed herein may be implemented and/or embodied as a driver, a library, an interface, an API, FPGA configuration data, firmware (e.g., stored on an EEPROM), and/or the like. In some embodiments, portions of the modules, components, and/or facilities disclosed herein are embodied as machine components, such as general and/or application-specific devices, including, but not limited to: circuits, integrated circuits, processing components, interface components, hardware controller(s), storage controller(s), programmable hardware, FPGAs, ASICs, and/or the like. Accordingly, the modules disclosed herein may be referred to as controllers, layers, services, engines, facilities, drivers, circuits, subsystems, and/or the like.

The modules **510** may comprise a routing engine **512**, a token generator **514**, an authentication engine **516**, and one or more APIs **518**. The routing engine **512** may be used to route API calls to a correct backend system based on the subscription ID within the API call. The token generator **514** and authentication engine **516** may be used to determine authorization of the API calls before accessing a backend system. The one or more APIs may be developed by data providers to access backend systems. An API may be common to multiple data providers and/or backend systems.

The input/output interface **508** may facilitate user interaction with one or more input devices and/or one or more output devices. The input device(s) may include a keyboard, mouse, touchscreen, light pen, tablet, microphone, sensor, or other hardware with accompanying firmware and/or software. The output device(s) may include a monitor or other display, printer, speech or text synthesizer, switch, signal line, or other hardware with accompanying firmware and/or software. For example, in one embodiment, the input/output interface **508** comprises a display to provide a graphical user interface (GUI) illustrating the potential ablation perimeters. The input/output interface **508** can receive the user input data **522**. In some embodiments, the input/output interface **508** is a touchscreen, and the size input is received via the touchscreen. In some embodiments, the input/output interface **508** can superimpose the target ablation perimeters on an image of the tissue.

The network interface **506** may facilitate communication with other computing devices and/or networks and/or other computing and/or communications networks. The network interface **506** may be equipped with conventional network connectivity, such as, for example, Ethernet (IEEE 1102.3), Token Ring (IEEE 1102.5), Fiber Distributed Datalink Interface (FDDI), or Asynchronous Transfer Mode (ATM). Further, the network interface **506** may be configured to support a variety of network protocols such as, for example, Internet Protocol (IP), Transfer Control Protocol (TCP), Network File System over UDP/TCP, Server Message Block (SMB), Microsoft® Common Internet File System (CIFS), Hypertext Transfer Protocols (HTTP), Direct Access File System

(DAFS), File Transfer Protocol (FTP), Real-Time Publish Subscribe (RTPS), Open Systems Interconnection (OSI) protocols, Simple Mail Transfer Protocol (SMTP), Secure Shell (SSH), Secure Socket Layer (SSL), and so forth.

The system bus **509** may facilitate communication and/or interaction between the other components of the smart router API gateway **500**, including the one or more processors **504**, the memory **503**, the input/output interface **508**, and the network interface **506**.

Any methods disclosed herein comprise one or more steps or actions for performing the described method. The method steps and/or actions may be interchanged with one another. In other words, unless a specific order of steps or actions is required for proper operation of the embodiment, the order and/or use of specific steps and/or actions may be modified.

While specific embodiments of stents have been illustrated and described, it is to be understood that the disclosure provided is not limited to the precise configuration and components disclosed. Various modifications, changes, and variations apparent to those of skill in the art having the benefit of this disclosure may be made in the arrangement, operation, and details of the methods and systems disclosed, with the aid of the present disclosure.

Without further elaboration, it is believed that one skilled in the art can use the preceding description to utilize the present disclosure to its fullest extent. The examples and embodiments disclosed herein are to be construed as merely illustrative and exemplary and not a limitation of the scope of the present disclosure in any way. It will be apparent to those having skill, having the benefit of this disclosure, in the art that changes may be made to the details of the above-described embodiments without departing from the underlying principles of the disclosure herein.

What is claimed is:

1. A method to route an API call, the method comprising: connecting a plurality of clients to a plurality of backend systems via an Application Programming Interface (API) gateway comprising a common API that is used by multiple of the plurality of backend systems, wherein connecting comprises: registering an application on one of the plurality of clients with the common API on the API gateway; receiving an indication of a target backend system that the application is to access using the common API, wherein the target backend system is one of the plurality of backend systems using the common API; assigning a unique identifier to the application; and associating the unique identifier with the target backend system; receiving, at the common API gateway, an API call comprising a unique identifier from the assigned unique identifiers; identifying the unique identifier in the API call; determining, via the common API, the target backend system associated with the unique identifier from the plurality of backend systems; and routing, via the common API, the API call to the target backend system based on the unique identifier;

wherein the unique identifier is within a header of the API call,

receiving a token with the API call and checking that the token is valid for the unique identifier of the API call.

2. The method of claim 1, wherein the API call corresponds to the common API that is common to multiple backend systems communicatively coupled with the API gateway.

3. The method of claim 1, wherein the unique identifier is a subscription identifier unique to an application and a client.

4. The method of claim 1, wherein the target backend system is implemented by one of a plurality of data providers using the common API.

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5. The method of claim 1, further comprising receiving a payload associated with the API call from the target backend system and sending the payload to a client computing device.

6. An API gateway comprising: an interface to communicate with a plurality of client computing devices comprising one or more applications and a plurality of backend systems; memory to store one or more APIs and one or more processors configured to: register each of the one or more applications with a corresponding API of the one or more APIs, wherein at least one of the one or more APIs is common to multiple backend systems; receive an indication of a target backend system for applications registered with an API common to multiple backend systems; assign unique identifiers to each application of the one or more applications on the plurality of client computing devices; associate each of the unique identifiers with one of the plurality of backend systems; receive an API call comprising a unique identifier from a client computing device; identify the unique identifier in the API call determine, via an API associated with the API call, the target backend system associated with the unique identifier from the plurality of backend systems; and route, via the API associated with the API call, the API call to the target backend system based on the unique identifier;

wherein the unique identifier is within a header of the API call,

comprising receiving a token with the API call and checking that the token is valid for the unique identifier of the API call.

7. The API gateway of claim 6, wherein the API call corresponds to an API that is common to multiple backend systems communicatively coupled with the API gateway.

8. The API gateway of claim 6, wherein the unique identifier is a subscription identifier unique to an application and a client.

9. The API gateway of claim 6, wherein the target backend system is implemented by one of a plurality of data providers using a common API.

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10. The API gateway of claim 6, wherein the one or more processors are further configured to receive a payload associated with the API call from the target backend system and send the payload to a client computing device.

11. An API call router comprising: memory to store an API associated with more than one backend system; one or more processors configured to: register an application on one of a plurality of clients with a common API that is used by multiple backend systems, receive an indication of a target backend system that the application is to access using the common API, wherein the target backend system is one of the multiple backend systems using the common API; assign a unique identifier to the application; associate the unique identifier with the target backend system; receive an API call corresponding to the API, the API call comprising a unique identifier from a client computing device; identify the unique identifier in the API call determine, via the common API, the target backend system associated with the unique identifier from the more than one backend systems associated with the API; and route, via the common API, the API call to the target backend system based on the unique identifier;

wherein the unique identifier is within a header of the API call;

wherein the one or more processors are further configured to receive a token with the API call and check that the token is valid for an application making the API call based on the unique identifier.

12. The API call router of claim 11, wherein the unique identifier is a subscription identifier unique to an application and a client.

13. The API call router of claim 11, wherein the target backend system is implemented by one of a plurality of data providers using the API.

14. The API call router of claim 11, wherein the one or more processors are further configured to receive a payload associated with the API call from the target backend system and send the payload to a client computing device.

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